冬季南極海における大気−海氷間の二酸化炭素交換

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Sea ice CO_2 flux in the Southern Ocean during mid-winter and early spring

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There seems little doubt that sea ice is permeable to CO_2 and other gases although air–sea ice gas flux is more or less inhibited at a brine volume fraction of less than 5% representing the threshold for fluid permeability of sea ice. Generally, air–sea ice CO_2 flux is at its minimum in winter due to low sea ice temperatures and consequently reduced permeability despite the fact the partial pressure of CO_2 in sea ice is usually high at that time and sea ice has therefore the potential to release CO_2 to the atmosphere. Here, we present first evidence that snow laden Antarctic sea ice can act as source for atmospheric CO_2 even during mid-winter and early spring. During a mid-winter cruise to the Weddell Sea (AWECS, 2013) and an early spring cruise off east Antarctica (SIPEX-2, 2012), due to thick insulating snow covers, the bottom of the snow and the surface of the sea ice were relatively warm (>–10°C) even though air temperature was sometimes below –30°C. In addition, in both areas, sea ice was characterized by high bulk-salinities, resulting in brine volume fractions that are generally higher than 5%. Automatic "open-closed" chamber measurements indicated positive CO_2 fluxes of up to +2.5 mmol C m^{-2} day^{-1}, illustrating that sea ice acted as a source of atmospheric CO_2. Higher fluxes were measured at bare ice surfaces after removing the snow. However, generally low snow densities (mean: 339 kg m^{-3}), indicating a permeable snow cover, facilitated degassing of CO_2 at the snow-air interface. Our results therefore suggest that even in the winter and early spring, Antarctic sea ice can act as CO_2 source for the atmosphere, particularly in areas with a thick insulating snow cover.